

NUPTIAL, PRE-, AND POSTNUPTIAL ACTIVITY OF THE THATCHING ANT, *FORMICA OBSCURIPES* FOREL, IN COLORADO

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ABSTRACT.—Observations and excavations of thatching ant nests from 1990 to 1994 at 2560 m in Colorado provided information on the numbers and behavior of males and winged and wingless queens. Nuptial activity was compared to that reported by other investigators at lower altitudes. Reproductives were observed from 24 June to 15 August. Activity was greatest in 1993 when reproductives were on 10 of 98 mounds in the area. Mating and swarming occurred on rabbitbrush 4 m from 1 nest 2–6 July. The number of wingless queens in 4 excavated nests varied from 0 to 198.

Key words: nuptial flight, *Formica obscuripes*, Colorado, thatching ant.

Information on the reproductive activity of the thatching ant, *Formica obscuripes* Forel, in Colorado is sparse (Gregg 1963). The purpose of this study is to help remedy the deficiency and to compare nuptial and pre- and postnuptial activity of the thatching ant at high altitude in Colorado with similar studies on this species at lower elevations in North Dakota (McCook 1884, Weber 1935, Kanno 1963, Wheeler and Wheeler 1963), Michigan (Talbot 1959, 1972), Illinois (Herbers 1978, 1979), Idaho (Cole 1932), and Nevada (Clark and Comanor 1972). The Nevada site north of Reno at 1550 m most closely approximates the Colorado study area in elevation and vegetation.

Mating flight plays a major role in the reproduction and dispersal of most social insects (Holldobler and Wilson 1990). Males and queens of *F. obscuripes* fly to "swarming grounds" as reported by Talbot (1972). There males fly back and forth in search of queens, which alight on low vegetation and release pheromones to attract males (Cherix et al. 1993).

MATERIALS AND METHODS

The main Colorado study area (64.6 × 114 m) has 85 mounds and is dominated by big sagebrush (*Artemisia tridentata* Nuttall). It is adjacent to a quaking aspen grove (*Populus tremuloides* Michaux) at an elevation of about 2560 m. The site is located in Gunnison County north of Blue Mesa Reservoir and west of Soap Creek road. Other plants in the study area are *Chrysothamnus nauseosus* (Pallas) Britton (rub-

ber rabbitbrush), *Purshia tridentata* (Pursh) de Candolle (antelope bitterbrush), *Lupinus argenteus* Pursh (silvery lupine), *Symphoricarpos rotundifolius* A. Gray (mountain snowberry), *Rosa woodsii* Lindley (Woods rose), *Urtica gracilis* Aiton (stinging nettle), *Penstemon strictus* Benth (Mancos penstemon), *Ipomopsis aggregata* (Pursh) Grant ssp. *aggregata* (trumpet gilia), 1 Saskatoon serviceberry tree (*Amelanchier alnifolia* var. *pumila*), and 1 Douglas-fir (*Pseudotsuga* sp.). Observations in this area took place on 5–6 August 1990; 20–28 June, 22–27 July, 13–15 August, 12–13 September, and 11 October 1992; 28 June–16 August 1993; and 29 June–31 July and 14–16 August 1994. Observations before 20 June were not possible due to academic commitments. A nest was excavated on each of the following dates: 6 August 1990, 27–28 June 1992, 12–14 July 1993, and 11–25 July 1994. The 1993 mound was poisoned with 1 1/2 cups Hi-Yield ant killer granules (Diazinon) wetted down with about 2 gal of water prior to excavation.

RESULTS AND DISCUSSION

Reproductives

Reproductives (males, winged and wingless queens) were observed in Colorado from 24 June to 15 August over 3 summers. Activity was greatest in 1993 when reproductives were found on 10 mounds scattered among 98 nests in the area: males, winged queens, and wingless queens on 5 mounds; males and winged

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queens on 3 mounds; a winged queen on 1 mound; and a wingless queen on 1 mound. Observations of both male and female alates on Colorado mounds support Herbers's (1978) observations that some nests produce a mixture of sexes. We were unable to confirm reports that some nests produce all males or all females (Kannowski 1963, Herbers 1978), or that a changeover from early all-male flights to later all-female ones occurs (Talbot 1959, 1972, Clark and Comanor 1972).

MALES.—Males were observed on 8 mounds from 28 June to 13 July 1993 and at 1 mound on 5–6 July 1994. Males seemed to prefer the shady side of 1 mound built around a fencepost. Workers sometimes chased males and once one carried a male on a mound. Others have reported males earlier in the year. Talbot (1959, 1972) saw males flying 16–24 June, and Clark and Comanor (1972) saw males from 15 April to 4 May.

Although males were observed from 0740 to 1635 hours in Colorado, they were most numerous and flew from 0938 to 1101. Talbot (1959) saw them fly even earlier, between 0608 and 1000. Clark and Comanor (1972) also saw morning flights, but noted males throughout the day (0840 to 1445).

The largest number of males on 1 Colorado mound was 10 on 3 July 1993, about the same maximum per mound (12) reported by Clark and Comanor (1972). Herbers (1979) noted up to 1264 males. Talbot (1959, 1972) reported even more males (up to 4500) but noted that the ratio of males to females varies from colony to colony and from flight to flight.

One male was found in a Colorado nest excavated in July 1993; none were in 3 other excavated nests. Wheeler and Wheeler (1963) reported males in nests from 23 May to 12 July.

WINGED QUEENS.—Winged queens were observed on 9 Colorado mounds from 28 June to 16 July 1993, and one was on a mound on 5 July and 10 July 1994. Workers pulled queens by their wings and antennae on mounds and were in turn sometimes dragged by queens. Queens were noted with tattered, spread, and partial wings from 30 June to 6 July. Others reported winged queens at nests earlier and later in the season than in Colorado. Clark and Comanor (1972) saw them as early as 1 May, and Wheeler and Wheeler (1963) reported winged females in nests as late as 8 August.

Winged queens were observed from 0654 to 1640 hours in Colorado, but most often in the morning. Clark and Comanor (1972) also saw them throughout the day, from 0830 to 1720. Those found later in the day were presumably remnants of the morning activity.

The maximum number of winged queens on 1 Colorado mound was about 50 on 3 July 1993. Others reported greater numbers per nest: 78 (Clark and Comanor 1972) and 230 (Talbot 1959). Winged queens were more abundant than males on Colorado mounds as reported by Clark and Comanor (1972), except on 1 occasion when males were more numerous. No winged queens were found in 4 excavated Colorado nests.

WINGLESS QUEENS.—Dealation was not observed in Colorado, but wingless queens were seen on 6 mounds and on trails from 24 June to 15 August between 0757 and 1742 hours. The greatest number on 1 mound was 7. Wingless queens were usually surrounded by a group of workers on the mounds who often pulled them by their antennae and legs and sometimes lunged at queens as if attacking them. Some were carried on the trails by workers. Dead wingless queens were observed being carried on a mound and a nearby dirt road.

The number of wingless queens in 4 nests excavated in Colorado varied greatly: 0, 1, 32, and 198. Five of the 198 queens from 1 nest were found with numerous workers amid a clump of rabbitbrush roots 1.5 m away from the excavated mound. Workers probably moved the queens along a trail from the main nest to a secondary nest at the rabbitbrush for safety during the prolonged excavation.

Kannowski (1963) stated that many species of *Formica* have more than 1 dealate queen per colony, and Cole (1932) reported 2 or more per *F. obscuripes* nest. The significance of the highly variable number of dealated queens per Colorado nest is unclear, and more excavations are necessary to determine the normal state of affairs. Observations of wingless queens on trails suggest that they may be transferred between mounds or adopted by existing colonies after the nuptial flight (Weber 1935).

Flight Season and Period

The time of year during which alates of a species in a given area fly is termed the flight season. Kannowski (1963) noted that species such as *F. obscuripes*, with a large geographical

distribution, may have a very long flight season over their range. In Colorado, queens flew 1–8 July and males 1–9 July. Although others noted flights as early as 1 May (Clark and Comanor 1972) and as late as September (McCook 1884), flights were more common in June and July (Cole 1932, Weber 1935, Talbot 1972). Talbot (1972) noted that the flight season varies greatly from colony to colony in any year and that colonies may have 5–16 flights. Interestingly, she found that colonies in sheltered nests or those on west-facing slopes flew later than those on open east slopes.

Each ant species has a flight period—the time of day that flights take place. Kannowski (1959) reported that most species of *Formica* have early morning flights. Queens flew between 0950 and 1141, and males between 0938 and 1101 in Colorado. Colorado flights did not begin as early (0500) or end as early (0750) as some reported by Talbot (1959) in Michigan, perhaps due to colder temperatures at high altitude in the morning. Reproductive activity subsided at Colorado nests between 1040 and 1107, or approximately at the same times (1030–1145) reported by Talbot (1972).

Emergence and Positioning

Reproductive emergence and positioning behavior in Colorado is similar to that reported by Kannowski (1963) and Weber (1935). Alates emerged, walked around, and went back into the entrances before leaving the mound and climbing nearby structures. Workers sometimes chased emerging alates or held onto their wings; at other times they seemed to ignore the sexuals. Males ignore winged queens at this time. Winged queens left Colorado mounds 1–8 July 1993 between 0818 and 1145 hours. Winged queens and males were found on the ground as far away as 7.85 m and 5.28 m from the mounds, respectively.

Reproductives often climb prior to flight. In Colorado they climbed nearby sagebrush, rabbitbrush, lupine, and grass, as well as dead sagebrush and a fencepost protruding from mounds. At the most active mound they climbed 3 sagebrushes, 0.48–0.89 m high, and 0.91–2.57 m away. Others have reported alates on nearby sagebrush and rabbitbrush (Clark and Comanor 1972), grass and herbs (Weber 1935), and timothy and bluegrass (Talbot 1959).

Although a number of Colorado reproductives flew from their perches, many did not.

Some queens descended 1–6 min after arrival, and one was pulled down by workers. Kannowski (1963) saw some alates wait longer (10–30 min) before flying from their perches. Tapping and blowing on perched queens did not induce them to fly.

A correlation between temperature and emergence and positioning was noted by Talbot (1972). She reported that alates began leaving mounds when the air temperature reached 17.2° C and began climbing plants at temperatures above 18.3° C.

Flights

In Colorado alates flew from grass, sagebrush, rabbitbrush, and lupine; a few took off from the ground. Prior to flying, some queens released their front legs and fanned their wings, as reported by Kannowski (1963). On the other hand, Talbot (1959) reported that queens flew quickly with little preliminary wing fluttering.

One Colorado queen flew east at least 13.1 m at an estimated altitude of 4 m. Another flight lasted about 20 sec at an estimated altitude of 9 m. Other winged queens moved away from mounds by alternately walking on the ground and making short, low flights between plants. One queen using this method moved 7.85 m away from a mound over a period of 37 min. Most queen flights were low and downhill to the east. Males generally had short (2.5 cm–1.5 m), flitting or hovering flights about a meter above the ground, sometimes relanding on the same vegetation from which they departed.

Reproductive activity was greatest in Colorado on clear, warm, windless days. All investigators agree that these are the most favorable conditions for flight. Wind suppressed reproductive activity at 0918 hours on 3 July 1993. Weber (1935) noted alates leaving the nest when the air temperature was above 15.5° C, humidity exceeded 50%, and the sky was clear. Others reported first flights at an air temperature at least 5° C higher. A Colorado male flew at 22.7° C. Talbot (1972) reported that alates flew at temperatures between 20.5° C and 27.2° C, and Clark and Comanor (1972) saw flights between 20.5° C and 26.5° C, but at a relative humidity of only about 18%. Talbot (1959, 1972) noted that wind gusts, rain, low temperatures, and dark skies stopped flights, and wet grass and gray skies delayed flying.

Colorado flights involved relatively few reproductives, but reports in the literature vary considerably. Weber (1935) believed there is no marriage flight because only 1 sexual or a few sexuals fly at a time. Kannoński (1963) saw 1 mass flight, but noted most flights were sparse or moderate. Talbot (1959), on the other hand, reported that 695 females and an estimated 4500 males flew over time. Rates of flying of 4–14 queens/min and 1–10 males/min have been reported (Talbot 1959, Clark and Comanor 1972).

There appears to be no agreement on the flight pattern. Talbot (1959) noted that most queens flew downhill and westward, but some had short, sporadic flights from plant to plant or to the ground as sometimes observed in Colorado. Colorado flights were generally at low altitude (estimate 4–9 m), downhill, and eastward toward the sun. Kannoński (1963) also noted that alates fly in the general direction of greatest light intensity. Others report that flights are often upward and out of view (12 m or more; Weber 1935, Kannoński 1963, Clark and Comanor 1972).

Swarming and Mating

Swarming is the process whereby alates aggregate to mate in the air or on the ground and vegetation (Kannoński 1963). Most swarming and mating in Colorado occurred 2–6 July 1993 between 1008 and 1125 hours on rabbitbrush 4.01 m from 1 mound. Mating was also observed on rabbitbrush beside another mound on 2 July and 6 July 1993. Talbot (1972) noted swarming earlier in the year and over a longer time period, namely, 4–17 June between 0700 and 1200.

Swarming in Colorado was similar to that described by Kannoński and Johnson (1969) and Talbot (1972). Queens arrived first on rabbitbrush, followed by males. Queens perched on the upper parts of plants often with their heads down and their abdomens pointing upward or toward the nest. Presumably they emit a pheromone to attract males (Kannoński and Johnson 1969, Walter et al. 1993). Once the female's pheromone is detected, males fly upwind to the general location of the female, fly quickly from stem to stem until they find her, alight, and then attempt to mate (Kannoński 1963). After mating, males usually fly off while the queen remains and sometimes inspects her abdomen.

Up to 7 in copulo alates were noted at 1 time at the Colorado swarming site 4.01 m away, 6 pairs on rabbitbrush and 1 pair on an adjacent lupine. Some pairs fell off the plants. One queen appeared to mate 2 or 3 times. Kannoński (1963) reported a queen mating 4 times. Two Colorado males tried to simultaneously mate with a queen for 1 min 40 sec and remained attached to each other for 20 sec after the queen left. Talbot (1972) noted 3 or 4 males trying to mate a queen, and Kannoński (1963) reported a single male may mate several times before flying away.

The durations of 6 Colorado matings ranged from 1 min 40 sec to 3 min 40 sec (mean = 2 min 43 sec), or within the 1- to 5-min durations reported by Talbot (1972).

Talbot (1959, 1972) noted larger, more diverse, and more heavily populated swarming areas than the small rabbitbrush area in Colorado. Some of her swarming areas were over short grass; others were on shrubs. One swarming area involved thousands of males hovering over hundreds of females from 3 colonies and covered an oval-shaped area 27.5×11 m. Males usually flew near grass level, but sometimes as high as 1.2–1.5 m. Another swarming area shifted somewhat from day to day and increased to approximately 41.3×32.1 m. She found that these areas were maintained throughout the flying season, and some were used year after year.

CONCLUSIONS

Preliminary studies of the reproductive behavior of the thatching ant, *E. obscuripes*, in Colorado are in general agreement with the literature. Time constraints on our seasonal observations probably explain why we did not observe reproductive behavior as early in the year as that reported in the literature. The most notable finding was the paucity of reproductive activity: swarming and mating were observed only 2–6 July 1993; 9 of 98 mounds (9%) in the area had winged reproductives; mating occurred near 2 mounds (2%); and a swarming area was found 4.01 m from 1 mound (1%). The numbers of males and winged queens were relatively low and the swarming area was small. Other notable findings were the highly variable number (0–198) of dealated queens per nest and the almost complete absence of winged alates in excavated nests.

Further studies are needed to determine whether our findings are anomalies or whether they represent the normal state of affairs for this species at high altitude.

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